

Karel the Robot

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**Personal
Computer
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Continued on inside back cover

Karel the Robot

Program by: Richard E. Pattis and
Turing Tarpit Software 1983
Produced by: Cybertronics International, Inc.

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**Personal
Computer
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First Edition (January 1984)

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About this Book

Organization

This Guide is designed to be used with either of the following textbooks:

- IBM Personal Computer *Karel the Robot—The Textbook*
- *Karel the Robot: A Gentle Introduction to the Art of Programming*¹

The Guide is divided into nine chapters:

- Chapter 1 introduces you to Karel the Robot and tells you what to do before you start the program.
- Chapter 2 shows you how to start Karel the Robot, how to set up your system and back up your Karel System diskettes, and how to run the Simulator demonstration.
- Chapter 3 shows you how to use the Configurer to define the way you want Karel and his world to look on your screen.
- Chapter 4 shows you how to use the Simulator to check your robot programs for errors and then run your robot programs.
- Chapter 5 shows you how to use the Editor to create new robot programs and make changes to existing robot programs.


¹ Pattis, Richard E., *Karel the Robot: A Gentle Introduction to the Art of Programming*. New York: John Wiley & Sons, 1981.

- Chapter 6 shows you how to use the World Builder to create new worlds and make changes to existing worlds.
- Chapter 7 shows you how to use the File Manager to keep track of the information on your diskettes.
- Chapter 8 combines everything you learned in this Guide with the last three chapters of the textbook to teach you advanced programming techniques.
- Chapter 9 shows you how to use the Simulator for advanced robot programming and debugging.
- The Reference Card provides information about the example problems and solutions from the textbook, as well as information about the sample worlds. These problems, solutions, and worlds are stored on the ANSWERS and the WORLDS diskettes.

Facts to Remember

We assume that you are familiar with the operation of your IBM Personal Computer and keyboard and the Disk Operating System (DOS) DISKCOPY command. Refer to your IBM Personal Computer *Guide to Operations* and the IBM Personal Computer *Disk Operating System* manual for detailed information about your computer, keyboard, and DOS.



Although there is more than one kind of keyboard, we assume that you are using the IBM PCjr keyboard, and this keyboard is referred to throughout this book. You'll have no problems, however, if you are using an IBM PC or an IBM PC XT keyboard.

When you are asked to type letters or numbers, just type the appropriate letters or numbers on your keyboard. When you are asked to press any special key, press the key that has a similar or matching symbol or a similar or matching label, for example, the  key.

Note: The symbols on the keyboards, in this Guide, and on your screen may not match exactly. This does not affect the operation of the program, however.

Refer to the appropriate section for your keyboard when you are asked to press a key combination:

- **IBM PCjr keyboard:**

- First, hold down the  key (where applicable), then press the  key once.

- Next, press the appropriate special key, such as the **PgUp** key or the **PgDn** key, to perform the function.
- Finally, release the **Ctrl** key.
- **IBM PC or IBM PC XT keyboard:**
 - There is no **Fn** key on this keyboard.
 - Press the appropriate key combination without including the **Fn** key.

As you go through the Karel the Robot program, remember these three important things:

1. Use your computer while you work through the chapters.
2. Read the information *carefully* and follow the instructions *exactly*.
3. *Be patient*. You won't be able to learn everything about structured programming all at once, so set a comfortable pace for yourself.

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Chapter 1. Introduction

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Let's Meet Karel

This small robot is well known to fame,
He is clever, and Karel is his name;
If you are his pal,
He will teach you PASCAL,
And turn programming into a game.

Isaac Asimov
February 7, 1983

Throughout this course, a friendly robot named Karel helps you explore the world of programming. The concepts in this Guide—as well as Karel's programming language, sample programs, and many programming tasks—are explained in detail in the textbook. Use the textbook, along with this Guide, as you experiment with the different parts of the Karel System.

Part of the fun of learning how to write simple program instructions is that they give you the ability to move Karel through his "world." As Karel responds to the simple instructions you give him, you can watch him move on your screen. Karel's world is displayed as a grid of intersecting streets and avenues that can contain walls and beepers—objects that Karel can sense and manipulate.

Highlights

The Karel System has five parts:

1. A *Configurer* lets you set up the system according to your experience level and particular IBM Personal Computer. You also can select the colors you want (if you have a color display), whether or not you want sound, and whether or not you want blinking beepers.
2. A *Simulator* lets you run and test your Karel programs. You can change both the speed and the level of detail in the Simulator. The Simulator also provides error messages about incorrect use of vocabulary and the grammatical arrangement of words in a program.
3. An *Editor* lets you write your own Karel programs. The Editor makes it simple to correct errors and make changes to a program.
4. A *World Builder* places walls and beepers on Karel's streets and avenues. With the World Builder, you can build walls, mazes, hurdles, and many kinds of situations to challenge Karel.
5. A *File Manager* provides a way for you to keep your Karel programs and worlds on diskettes.

What You Need

In order to use Karel the Robot, you need these items:

- An IBM PC, an IBM PC XT, or an IBM PC_{jr} with at least 128KB of memory
- A dual-sided diskette drive
- An IBM display or a TV
- The IBM Disk Operating System (DOS) Version 2.00 or higher
- The Karel the Robot package, which contains these six items:
 - The textbook
 - The KAREL diskette, which contains the Karel System
 - The WORLDS diskette, which contains pre-built worlds for all the problems in the textbook
 - The ANSWERS diskette, which contains the answers to the textbook problems and examples of programs from the textbook
 - A Reference Card, which lists each problem and solution stored on the ANSWERS diskette and each world stored on the WORLDS diskette
 - This Guide
- An IBM Personal Computer printer or compatible printer (optional)

- The Student package (for the classroom only),
which contains these three items:
 - The KAREL diskette
 - The textbook
 - This Guide

Files, Filenames, Filename Extensions, and Diskette Drives

This section contains some important information about files, filenames, filename extensions, and diskette drives. You need to know this information in order to use the Karel System efficiently. Don't try to remember all of this now, however. Just refer to this section whenever you need to know something about files and filenames. As you work with Karel, you'll become familiar with this information.

You save a Karel program or world in a *file*. Each file has a *filename* that is 1 to 11 characters (letters, numbers, or symbols) in length.

Files also can have extensions at the end of their names. A filename *extension* starts with a period and can be 1 to 3 characters in length.

In the Karel System, the Editor automatically gives all files that contain *robot programs* **.PRO** as their extension. The World Builder automatically gives all files that contain *worlds* **.WOR** as their extension.

Notes:

1. A filename can be 15 characters in length *if it does not require a filename extension*.
2. You can type the diskette name plus the filename (for example, **KAREL:practice**) instead of typing the drive letter and then the filename (for example, **b:practice**).

If the diskette or filename isn't found, a message appears identifying the problem.

The Robot Symbol

This *robot symbol* appears at various times as you are reading through this Guide:



This symbol acts as a pointer. It tells you that you will be leaving the Guide to do reading and problem-solving assignments in the textbook. Follow the directions to the right of the symbol to complete the textbook assignments.

Before You Begin



Now, set aside this Guide and carefully read "Chapter One—The Robot World," in the textbook. This chapter introduces you to Karel's world and to his robot capabilities.

As you read, pay special attention to each of these terms, because you'll be using them throughout this course:

wall	section	corner	task
final	situation	avenue	wall
initial	situation	situation	origin
programming	language	beeperbag	street
beeper		program	

When you complete your reading of Chapter One and you're familiar with the terms defined in that chapter, return to this Guide and work through "Chapter 2. Getting Started."

Chapter 2. Getting Started

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Setting up Your System

Once you've read Chapter 1 in this Guide and Chapter One of the textbook, you're ready to start using Karel the Robot.

Notes:

1. Throughout this Guide, all screens and messages are shown in 80-column mode (80 characters per line). Some screens and messages appear differently in 40-column mode (40 characters per line). This does not affect the operation of the program, however.
2. Whenever you are asked to type something that appears in UPPERCASE letters in this Guide, you can use either UPPERCASE (capital) or lowercase (small) letters.

Important: The first time you start the Karel the Robot program, *make sure your computer is OFF*.

When your computer is off, follow these steps to start Karel the Robot:

- 1 Insert your KAREL diskette in drive A. (Drive A is the one on the left if you have a dual-drive system.)
- 2 Turn on your computer.
- 3 Turn on your display.

System Setup


The first time you use Karel the Robot, the System Setup screen appears on your screen. This message appears at the top of your screen:

Display Type (Monochrome, Color, or Black/White)[M]_

This message is followed by an explanation of the System Setup.

- *Monochrome* appears only if you have both a Monochrome and a Color Monitor attached to your System Unit.
- If you do not have the Color/Graphics Adapter card, you do not see the first option, **Display Type**. The Karel System assumes you have a Monochrome monitor attached to your System Unit. In this case, the message explained in step 2 appears.

Study the System Setup screen for a few moments. Then, follow these steps to set up your system and format a blank diskette for use when making a copy of your KAREL diskette:

- 1 *If you have a monochrome monitor, type M or press the  key.*

This message appears briefly:

Display size will remain 80...

If you typed **M**, go to step 2.


If you have a color display, type C.

If you have a black/white display, type B.

This message appears on your screen for either a color display or a television:

Display size (40 or 80 column)[8]:_

If you wish your screens to appear in 40-column mode, type **4**.

If you wish your screens to appear in 80-column mode, type **8** or press the  key.

2 Regardless of your display type, this next message appears on your screen:

Make a specially formatted diskette for backing up KAREL (Yes or No)[Y]:_

We recommend that you make backup copies of your Karel System diskettes in case of accidental damage to your original diskettes. To back up your KAREL diskette, you first need to format a blank, double-sided diskette.

To format a blank diskette, type **Y**.

Note: If you type **N**, you go to the Karel System Menu.


This message appears on your screen:

Do you have a blank, double-sided diskette (Yes or No)[N]:_

3 Type **Y** to continue with the formatting process.


Note: If you type **N**, you go to the Karel System Menu.

This message appears next:


Put a blank diskette with NO WRITE-PROTECT sticker
in drive A and then close the cover. 

Note: The write-protect sticker is the silver piece of tape over the notch in the diskette. You always must remove this sticker before the program writes anything on the diskette.

At the bottom of your screen, you see a warning not to do a system reset before the IBM logo screen. You'll learn how and when to do a system reset in the next section.

- 4 Remove your KAREL diskette from drive A, and insert your blank diskette in drive A. Then, press the  key. After several seconds, this message appears on your screen:

Formatting successful; please put the KAREL diskette back into drive A.
You can back up the KAREL diskette by using DISKCOPY in DOS Version 2. ↵

- 5 Remove your formatted diskette, and insert your KAREL diskette in drive A. Then, press the  key.

When the IBM logo screen appears, go on to the next section, "Backing up Your Program Diskettes."

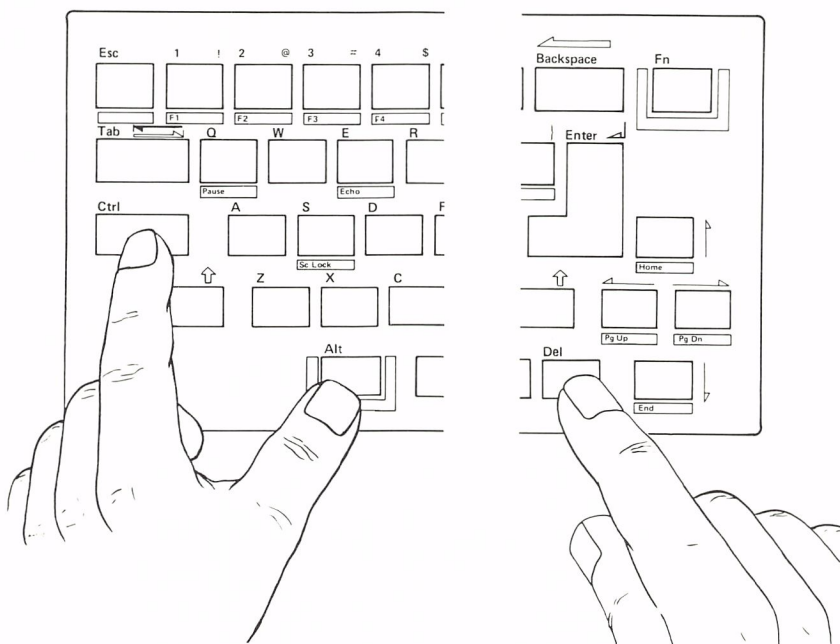
Backing up Your Program Diskettes

Now, remove your KAREL diskette from drive A, and insert your DOS diskette in drive A. Then, use the DOS DISKCOPY command to make backup copies of your KAREL, ANSWERS, and WORLDS diskettes. Refer to your IBM Personal Computer *Guide to Operations* or your IBM Personal Computer *Disk Operating System (DOS)* manual for instructions on starting DOS and backing up diskettes.

Remember: Use the diskette that you formatted in the System Setup procedure as the backup for your KAREL diskette.

When you are through making backup copies of your diskettes, remove your DOS diskette from drive A. Now, you can restart the Karel the Robot program as you did in "Setting up Your System" (if your computer is off), or you can follow these steps if your computer is on:

- 1 Insert your KAREL diskette in drive A.
- 2 Hold down the **Ctrl** and the **Alt** keys, then press the **Del** key.



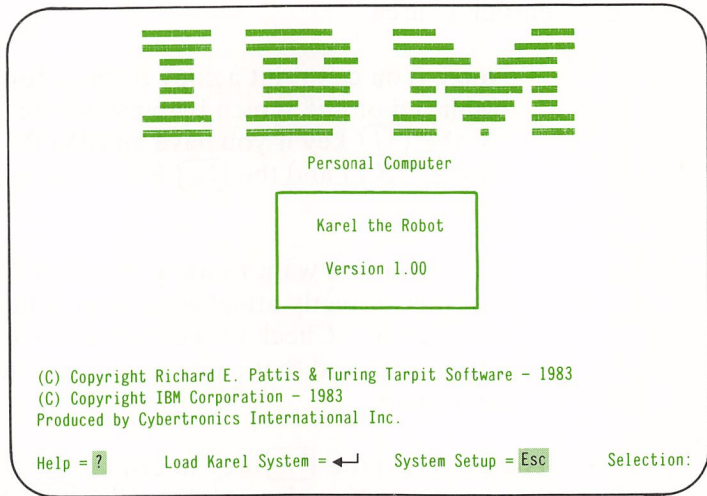
3 Release the keys.

This is called a *system reset*. Once you've backed up your Karel System diskettes, you can do a system reset to start Karel the Robot whenever your computer is on.

IBM Logo Screen

You are ready to begin using Karel the Robot when the IBM logo screen appears.

This screen looks like this:





- You can press the  key and the  key at the same time for Help.




While using any part of the Karel System, you can take advantage of the Help information that is available. When you see **Press ? for Help** on your screen, it means that additional information is available. One important type of Help information is a short description of all of the commands that you can use with that part of the System.

In some cases where you are asked a question and must respond, Help is also available, even though the message doesn't appear on the screen.




For example, in the World Builder, if you ask for Help before you type your response to the message, you are given additional information that explains


the response the World Builder expects and accepts. Also included are some hints on how to make the correct response.

Throughout the Karel System, try asking for Help on different screens to see where such information is provided. Just press the  key and the  key at the same time to see the Help screen for a particular area.

Note: You can print a copy of the information displayed on the screen by pressing the  key (or the  key if you have an IBM PC or an IBM PC XT) and the  key at the same time.

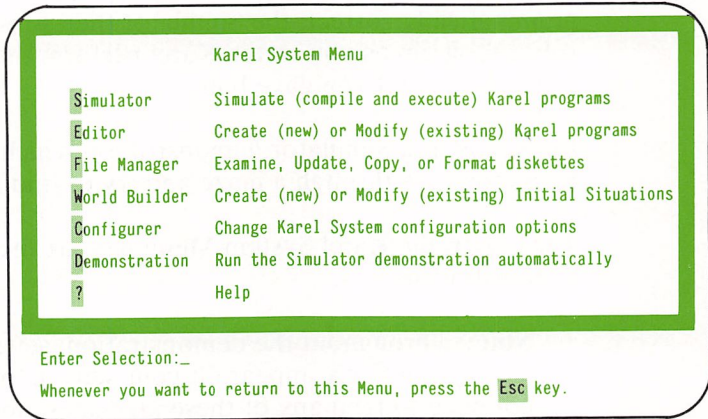
Whenever you want to use your printer, be sure that it is correctly attached to your computer and is turned on. Check to see that the Online button is lit and that paper is properly inserted in the printer.

- You can press the  key to display the System Setup screen. You also can press the  key (except on the logo screen) at any time to stop what you're doing and return to the Karel System Menu.
- You can press the  key to begin loading the Karel System.

Now, press the  key to see the Karel System Menu.

The Karel System Menu

After several seconds, your screen looks like this:



This is the **Karel System Menu**. It lists the different *options* (choices) that Karel the Robot offers you. Take a few moments to study this screen. You already are familiar with what each of these sections of the Karel System does from your introductory reading.

Now, let's look at a demonstration of how the Simulator works with your robot programs.

The Karel Simulator Demonstration

The Simulator lets you first check your robot programs for grammatical accuracy. If the program is grammatically correct, the Simulator then runs your robot program as you watch Karel perform the instructions that you gave him.

Let's look at a Simulator demonstration which instructs Karel to move through a maze and try to find a beeper.

Type **D** on the Karel System Menu to start the demonstration.

Note: Throughout the demonstration, several messages quickly appear on your screen. You do not need to read any of these messages, however.

After a few seconds, the demonstration displays the robot program line-by-line, then it displays Karel's world. Finally, Karel performs the task—he moves through the maze and finds the beeper. After the demonstration is finished, you return to the Karel System Menu.

Type **D** if you want to see the demonstration again. If you don't want to see the demonstration again, don't type anything. In Chapter 3, you'll learn how to use another menu option.

Summary

In this chapter, you learned how to start Karel the Robot, how to make backup copies of your Karel System diskettes, and how to use the Karel System Menu to run the Simulator demonstration.

Now, go on to Chapter 3, where you'll practice using the Configurer.



Chapter 3. The Configurer


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
Configuring Your System

The Karel System lets you *configure* (define) the way you want Karel and his world to look on your screen. When you answer each question as it appears, you select the *configuration options*; that is, you tell the Configurer the kind of display you are using, the diskette drive you want to be the default drive, the foreground and background screen colors you want, and more.

Notes:

1. A *default value* is the one that the program automatically chooses for you if you don't specify a particular value. In Karel the Robot, the default value is enclosed in brackets []. To select the default value, either type the letter that appears in the brackets, or press the  key.
2. Depending on your system and display, the default values on your screen may differ from the examples in this Guide. This does not affect the operation of the program, however.

You also can change your options at any time. Whenever you change options, be sure to remove the write-protect sticker (if there is one) on the KAREL diskette so the Configurer can write your new configuration onto the diskette.

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the  key (if the Karel System is on).

- 1 Once the Karel System Menu is on your screen, type C to start the Configurer. The first option question appears on your screen:

Display Type (Monochrome, Color, or Black/White)[M]:_

- *Monochrome* appears only if you have both a Monochrome and a Color Monitor attached to your System Unit.
- If you do not have the Color/Graphics Adapter card, you do not see the first option, **Display Type**. The Karel System assumes you have a Monochrome monitor attached to your System Unit. In this case, the message shown in step 2 appears on your screen.

2 If you are using a color display, type **C**.

If you are using a black/white display, type **B**.

If you have a monochrome monitor, type **M**.

This next option appears on your screen:


Default Diskette Drive for Programs and Initial Situations (A or B)[A]:_

In deciding whether to change the default drive from A to B (if you have a dual-drive system), keep in mind that there is room on the KAREL diskette to store approximately 35 programs and worlds. Since the KAREL diskette must remain in drive A while you are using the Karel System, this means you can use the default drive (A) for a while.


If, however, you prefer to keep your programs and worlds on a diskette other than the KAREL diskette, you need to make drive B your default drive. You can keep your KAREL diskette in drive A and save all your programs and worlds on the diskette in drive B.

- For all of the examples in this Guide, the default drive is shown as drive A.
- If you select drive B as the default drive, you need to insert a blank, formatted diskette in


that drive. For information about formatting blank diskettes, refer to "Chapter 7. The File Manager."

- 3 Press the  key to use the default drive (A), or type **B** to change the default drive to drive B. This option appears on your screen:

User Level (Beginner or Experienced)[B]:_

- 4 To continue using the system configured for a beginner, press the  key. This option appears on your screen:

Include Sound (Yes or No)[Y]:_


- 5 Press the  key to continue using sound, or type **N** to turn the sound off.

If you selected monochrome or black/white, skip steps 6 through 11, and go directly to step 12.

If you selected color, this next message appears, along with the complete color chart. Each color is labeled with a letter and a color name.

Default Foreground (A .. P see Color Chart)[H]:_

- 6 The default foreground color is white [H]. If you wish to change the foreground color, type any letter from **A** to **G** or **I** to **P**.


If you wish to continue using the default color, just press the  key.

The next color choice is background color:

Default Background (A .. H see Color Chart)[B]:_

The default background color is blue [B].

- 7 If you wish to change this color, type **A** or any other letter from **C** to **H**.

If you wish to continue using the default color, just press the  key.

Now, you can choose Karel's color:

Karel (A .. P see Color Chart)[P]:_

At present, Karel is bright white. Although you can change Karel's color to any of those on the color chart, you should limit your choice to any of the light, bright shades (J-P) in the right column so he shows up clearly on the screen.


- 8** If you wish to change Karel's color, type any letter from **A** to **O**.

If you wish to keep Karel bright white, just press the  key.

You also can decide what color you want the corners (dots) to be:

Corners (A .. P see Color Chart)[H]:_


- 9** The corners currently appear as white dots. If you wish to change the color of the corners, type any letter from **A** to **G** or **I** to **P**.

If you wish to continue using the default color, just press the  key.

Next, you are asked to choose the color for the walls:

Walls (A .. P see Color Chart)[M]:_


- 10** At present, the walls are light red. If you wish to change the wall color, type any letter from **A** to **L** or **N** to **P**.

If you wish to continue using the default color, just press the  key.


Now, you can choose what color you want the beepers to be:

Beepers (A .. P see Color Chart)[0]:_

- 11** At present, the beepers are yellow. If you want to change the color, type any letter from **A** to **N** or type **P**.

If you want to keep the beepers yellow, just press the  key. This message appears on your screen:



Blink Beepers (Yes or No)[N]:_

- 12** Type **Y** if you want the beepers (numbers) to blink in each world, or press the  key to stop the blinking.

After you respond to this option, the Simulator draws a sample world on your screen, and you see this message:

Is this the configuration you want to use? (Yes or No)[N]:_


Now, you have answered all of the option questions and are ready to configure the Karel System. Carefully check your screen to make sure that the options are set to your liking.

- 13** *If there is something you want to change, press the  key to see the option questions again. Continue to press the  key for the questions that you don't want to change, or type the appropriate letter for each question you do want to change.*

If this is the configuration you want to use, type Y.

After a few seconds, this final message appears on your screen:

Configuration successfully saved. 

- 14** Press the  key. You return to the Karel System Menu.

Summary



Now that your system is configured to your liking, go to your textbook and carefully read Chapter Two. Pay special attention to the example material because the first practice problem with the Simulator is *the beeper-transportation task*.

Also, pay attention to the meanings of each of these terms, because you'll be using them throughout this course:

execute	execution error
error shutoff	intent error
primitive instructions	instructions
turn-on button	bug(s)
execute-program button	debug
reserved words	move
simulate	turnleft
delimiters	pickbeeper
lexical error	putbeeper
syntactic error	turnoff
DEFINE-NEW-INSTRUCTION	BEGIN/END blocks

When you complete your reading, return to this Guide and work through the next chapter, "The Simulator—The First Time."

Chapter 4. The Simulator—The First Time

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Practicing with the Simulator

As you saw in the demonstration program, the Simulator checks for grammatical errors in each robot program that you write and explains any errors that it finds. If there are no grammatical errors, the Simulator then runs your robot program. In this chapter, you follow simple instructions that take you through your first use of the Simulator.

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the Esc key (if the Karel System is on).

Once the Karel System Menu is on your screen, type S to start the Simulator. After a few seconds, you see this screen:

Enter the name of the file containing Karel's program: _

Default disk drive is A. Default extension is ".PRO"

Karel program files currently on the Karel diskette in drive A:

BEEPTRANS.PRO

To see which files are on a diskette, type A: or B: and then press ←


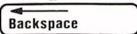


For help, press ?. To return to the Karel System Menu, press Esc.



This screen tells you that a program named **BEEPTRANS.PRO** is stored in a file for you. This program is the sample *beeper-transportation task* from Chapter Two of the textbook. A second file, **BEEPTRANS.WOR**, also is stored on this diskette. This file contains an *initial situation*, or world, through which Karel moves. BEEPTRANS.WOR is not listed on your screen because it is not a program and, therefore, cannot be used yet.

Let's use these files to practice working with the Simulator:

1 Type **BEEPTRANS** and press the  key.

- If you make a mistake typing the filename and haven't pressed the  key, just use the  key or the  key to move the cursor back, then retype the correct filename.
- If you enter an incorrect filename, the Simulator sounds a short beep. When you are asked for the program filename again, retype the correct filename and press the  key.


After two brief messages, the Simulator reads the program and displays it line-by-line, giving additional comments and information as it does so. The Simulator points out errors in spelling and grammar, errors in indenting BEGIN/END blocks, and errors in the sequence of your program instructions.

Because the sample file, BEEPTRANS.PRO, is correct, when Karel finishes checking and displaying the program, the screen is cleared. Then, this message appears on your screen:

Karel's program contains no lexical or syntactic errors. ←

Lexical errors happen when you use words in your robot programs that Karel doesn't know. *Syntactic errors* happen when you use the right words in the wrong order or with incorrect punctuation.

2

Press the  key to continue using the Simulator. This screen appears on your screen:

Enter the file name containing the Initial Situation

[A:BEEPTRANS.WOR]:_

Default disk drive is A. Default extension is ".WOR"

Initial Situation files currently on the Karel diskette in drive A:

BEEPTRANS.WOR


P21.WOR

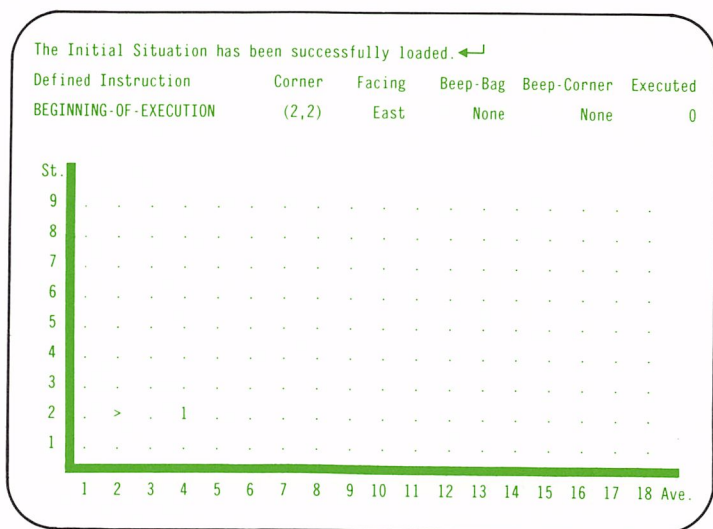
To see which files are on a diskette, type A: or B: and then press ↵

For help, press ?. To return to the Karel System Menu, press Esc.

The Simulator doesn't know whether your program can do what you want it to do. To find that out, you have to watch the Simulator try to *execute* (run) your program with the initial situation (world) you've chosen to use.

Since you're just practicing now, use the file named **BEEPTRANS.WOR**.

- 3 Press the  key to use the practice world.
After two brief messages, you see Karel's world:



This screen contains important information:

- The top line on the screen—the *Simulator message line*—is where all Simulator messages appear.
- The second line contains the heading for each piece of status information, such as *Corner* and *Facing*.
- The third line contains the *status information* as Karel moves through a program in the world. You're given such information as the corner on which Karel is located and the direction in which he is facing.
- The left side of the screen shows the *street numbers* in Karel's world.

- The bottom line shows the *avenue* numbers in Karel's world.
- The thick solid lines show the western and southern boundaries of Karel's world.
- The dots are corners of streets and avenues. Walls, when they exist, are thin solid lines. Walls always begin and end midway between corners.
- The V-shaped figure is Karel, and the point of the V shows in which direction Karel is facing. (In this case, Karel is facing east.)
- The **1** on the corner of 2nd Street and 4th Avenue shows that there is one beeper on this corner.

Note: In the textbook, beepers are shown as two circles, one inside the other.

Only one character at a time can appear on any corner. The rules that determine which character appears are listed for you:

- If Karel is on a corner, his shape is printed.

Note: If Karel is on a corner that also contains beepers, only Karel appears on the corner. The number of beepers on that corner then appears on Karel's status line under the heading **Beep-Corner**. The beepers appear after Karel leaves the corner.

- A dot shows a corner with no beepers.
- The numbers **1** through **9** indicate a corner with nine or fewer beepers.
- The pound sign (**#**) shows more than nine beepers on a corner.


- The infinity symbol (∞) shows an infinite number of beepers on a corner.

In the example world, Karel starts at the corner of 2nd Street and 2nd Avenue. He has to move to the corner of 2nd Street and 4th Avenue and pick up the beeper in order to do *the beeper-transportation task*. (For a discussion of this task, refer to Chapter Two of the textbook.)




This message appears on the top line of the screen:

The Initial Situation has been successfully loaded. ←

- 4 After you've studied this world for a while, press the  key to continue using the Simulator. This message appears on your screen:


The Simulator is ready to execute Karel's program. ←

- 5 Press the  key again. The Simulator runs the beeper-transportation task.

- 6 When the Simulator is finished running the program, this message appears on your screen:

Karel executed a "turnoff". There were no execution errors. ←

This means that Karel performed the task successfully. Study the *final situation* (where Karel is when he completes a task) to see if it matches the one in the Textbook.

Then, press the  key to return to the Karel System Menu.

Summary

This ends your practice session with the Simulator. Remember, you can repeat these practice steps as often as you want.



Once you feel comfortable using the Simulator, go to Chapter Two of the textbook and read Problems #1 and #2. Write out the solutions to these problems. When you're finished, return to this Guide and go on to the next Chapter, "The Editor."

Chapter 5. The Editor

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Reference Information







Working with Large Robot Programs

Robot programs can contain no more than 8,500 characters. Most are less than 1,000 characters. If you approach the upper limit, a *character countdown* appears on the double line near the top of the screen. This countdown appears when there is space left for fewer than 500 characters.

After every 1,000 keystrokes, a message appears to remind you to save your program. It's a good idea to get in the habit of saving your program every so often (perhaps after every two screens). Then, you are protected in case of a power failure or in case you go back into a program and accidentally erase some lines of text.

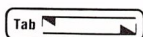
Editor Commands


You use these keys and key combinations when creating and modifying your robot programs in the Editor:

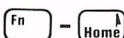
Command	Result
 	Moves the cursor one character up or down
 	Moves the cursor one character left or right
 	Moves the cursor to the left, to the beginning of the line (the first displayed character) or to the left margin



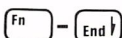
Moves the cursor right to the last displayed character



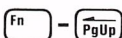
Moves the cursor 10 characters to the right or left, depending on whether the  key is used



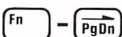
Moves the cursor to the first row and first column of the screen



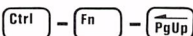
Moves the cursor to the first column and last row of the screen



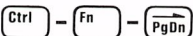
Moves backward 23 lines toward the beginning of the file



Moves forward 23 lines toward the end of the file



Moves the cursor to the first line in the file



Moves the cursor to the last line in the file



Lets you insert characters at the cursor or add one or more blank lines on which you can type more information

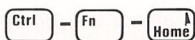
Note: When Insert mode is active, **Insert Mode** appears highlighted on the double line near the top of the screen. Insert mode remains active until the key is pressed a second time.



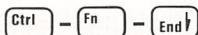
Deletes the character at the cursor



Deletes the character before the cursor and moves the cursor to the left one position



Deletes all characters before the cursor to the beginning of the line



Deletes all characters from the cursor to the end of the line



Inserts one blank line above the line where the cursor is located




Deletes one entire line where the cursor is located



Breaks, or splits, a line


To use this key combination:

1. Position the cursor at the beginning of the word that you want on the new line.
2. Press the  key and type **B** at the same time. The line of text from the cursor to the right margin automatically moves down to the next line.



Joins two adjacent lines

To use this key combination:

1. Position the cursor at the end of the line to which you want to add.
2. Press the  key and type **J** at the same time. The beginning of the following line automatically moves up to the cursor location.

Note: The Join command does not move any leading spaces or blanks. If the line

you are moving up to join a preceding line was indented, as in a program instruction, the extra spaces are ignored.

Alt U

Undoes recent changes to the current line of text

Alt A

Realigns (or re-indents) text in your program

To use this key combination:

1. Move the cursor to the *first* line you want to realign.
2. Press the **Alt** key and type A at the same time.
3. Press either the **PgUp** key or the **PgDn** key to move the first line to its new position.
4. Press the **End** key for each *following* line(s) you want to move to the same new position.

You also can start by marking the *last* line you want to realign, if that happens to be more convenient. Then, realign the *previous* line(s) by pressing the **Home** key for each line you want moved.

Note: When Align mode is active, **Align Mode** appears highlighted on the double line near the top of the screen. Align mode also has its own Help information.

5. When you are finished, press the **Alt** key and type **A** again.

Alt **L**

Lets you move or duplicate lines of text within your program.

To use this key combination:


1. Move the cursor to a line you want to move.
2. Press the **Alt** key and type **L** at the same time.

The line appears highlighted.



Line-Move mode appears highlighted on the double line near the top of the screen. Line-Move mode also has its own Help information.

3. If you want to move more than one line, use the **Home** key to mark and include *previous* line(s) in the move. Use the **End** key to mark and include *following* line(s).
4. When you have marked all lines to be moved, press the **Alt** key and type **L** at the same time. This stops the line marking. All the lines you want to move are highlighted.
5. Move the cursor to the new starting point for the text you are moving or duplicating.

Note: Up to this point, you still can cancel the move

operation by pressing the  key and typing **C** at the same time.

6. Decide whether to *move* or *duplicate* the text.

- To *move* the text, press the  key and type **M** at the same time. The text appears at the new location and is erased from its former location.
- To *duplicate* (copy) the text, press the  key and type **D** at the same time. A *copy* of the text appears at the new location, and the original text remains where it was.

After either a move or a duplication, you return to normal edit mode.

 **P**

Prints a copy of your Karel program (if you have a printer)

 **Q**

Quits the Editor (saving your Karel program is optional)

 **S**



Saves the program and quits the Editor

Note: This key combination tells the Editor you are through working on the current program and want to save it. The Editor always assumes you want to save an existing program in the same file in which you saved it before.

However, if you try to save a program in an existing file (but not the file you read the program from to begin with), you see this message:

File already exists; replace it with current copy. (Yes or No)[Y]:_

This prevents you from accidentally writing over another file and losing the information.

As you work with the Editor, you can press the  key and the  key at the same time to see information about special Editor commands.


Practicing with the Editor

The Editor lets you write, correct, change, and save your original programs using Karel's programming language. This language includes five *primitive* (simple) instructions:

- move
- turnleft
- pickbeeper
- putbeeper
- turnoff

There are also ways to define your own new procedures:

- DEFINE-NEW-INSTRUCTION
- BEGIN/END blocks

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the  key (if the Karel System is on).

Once the Karel System Menu is on your screen, type **E** to start the Editor. After a few seconds, you see this screen:

Load which Karel program file (press **↵** to create a new one):

Default disk drive is A. Default extension is ".PRO"

Karel program files currently on the Karel diskette in drive A:


BEEPTRANS.PRO

To see which files are on a diskette, type A: or B: and then press **↵**


To return to the Karel System Menu, press the **Esc** key.


Take a few moments to study this screen. To edit an existing file, you type the appropriate filename. To create a new file, you press the **Enter** key.


Creating a New File

Press the  key to create a new file. This message appears on your screen:

Editing a NEW Karel program file (not yet saved on diskette). Press ? for help.

The cursor is blinking in the upper left-hand corner of the screen, just below the bar. Press the  key. The words **Insert Mode** appear near the right end of the bar that forms the second line of the screen. *Insert mode* lets you insert characters at the cursor. The existing text moves to the right as you type.

Press the  key again. The words disappear. This is how you check to see whether you are in Insert mode.


To the right of the insert message, you see two numbers. The first number shows the line being edited (the line on which the cursor is located). The second number shows the total lines in the program. As you type your program, notice that these numbers change as you press the  key.



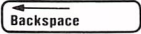
Now, you are ready to practice using the Editor commands to create a new program. Turn to Chapter Two of the textbook, and find problem #1. Follow these steps to begin typing the program for Problem #1:

1 Type this line exactly as shown:

BEGINNING-OF-PROGRAM


2 Press the  key.

3 Press the Spacebar twice to move the cursor two spaces to the right.


Remember: If you space too far, just use the  key to back up to the correct space.


4 Type this line exactly as shown:


BEGINNING-OF-EXECUTION

5 Press the  key.



6 Press the Spacebar twice.

7 Type **move;** and then press the  key.



Note: Notice that the cursor moved down one line when you pressed the  key, but it only moved left as far as the **m** in *move*. The Editor assumes that you want to continue typing more instruction lines at this indentation level.


8 Let's make a mistake and see how to fix it. Type **trunlfte;** and then press the  key.

Now, let's use some of the Editor functions to correct the misspelled command:



- First, let's switch the **u** and the **r**. Press the  key to move the cursor up to the previous line. The cursor is now under the **t** in *trunlfte*.
- Press the  key until the cursor is under the **r**, then type **ur** to switch the letters.

Next, let's insert the missing **e** following the letter **l**.


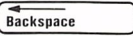

- Press the  key until the cursor is under the **f**.
- Press the  key to begin Insert mode.
- Type **e**. This letter appears between the **l** and the **f**.

- Press the  key again to leave Insert mode.

Finally, let's delete the **e** at the end of the word.

- Press the  key until the cursor is under the last **e**.
- Press the  key. The **e** disappears and your **turnleft;** command is now correct.

9 Finish entering the program for Problem #1:

- Type each line exactly as it appears in the textbook.
- Press the  key at the end of each line.
- Use the  key or the  key to move the cursor to the left of the last indent when you type the final two lines of the program.

When you finish typing the program, carefully check it and make any corrections so that it appears exactly as it does in the textbook. When everything is correct, you are ready to save your program and leave the editor.

Leaving the Editor

There are two ways you can leave the Editor when you are through working on a file:

- Save your program in a file and leave the Editor
- Quit the Editor—decide whether to save your program, then leave the Editor

The *Save* command (**Alt** S) saves a copy of your program in a file that you specify.

The *Quit* command (**Alt** Q) exits the Editor and then lets you decide whether or not to save your file.

With both of these commands, you have three choices:


- Leave the Editor and go directly to the Simulator.
- Stay in the Editor and continue working on the current file. (You may want to save a file from time to time as you work on it.)
- Quit the Editor and return to the Karel System Menu.

Let's practice leaving the Editor:

- 1 To save your program, press the **Alt** key and type S at the same time. This message appears on your screen:

Save this Karel program in which file: _

You need to give your program a filename. For now, include the chapter and problem number from the textbook as your filename. For example, PROBLEM21.PRO is from Chapter 2, Problem #1. This helps you recognize your files quickly and easily.

- 2 Type **PROBLEM21.PRO** and then press the  key. After a few seconds, this message appears on your screen:

Options (Karel System Menu, Start Simulator, Continue editing)[K]:_


- 3 Type **S** to go to the Simulator and check the accuracy of your program.

Finding Errors in Your Program

When you enter the Simulator from the Editor, you see this message:


```
Enter the name of the file containing Karel's robot program  
[A:PROBLEM21.PRO]:_
```

The Simulator always displays the name of the file you were working on when you saved it and left the Editor. Let's look at this file now:

- 1 Press the  key to start the Simulator reading and displaying your program line by line. If you entered the program in Problem #1 correctly, this message appears on your screen:

```
Karel's program contains no lexical or syntactic errors. ←
```


Note: If this message does not appear, there is probably a typing error in your program. Carefully check the original program in the textbook against your typed copy to find the error(s), return to the Editor, correct any problems, then return to the Simulator again.

- 2 If the message does appear, press the  key. This message appears on your screen:

```
Enter the file name containing the initial situation: _
```




The world for this program is shown in Chapter Two of the textbook, and it is stored in a file named **P21.WOR** on your KAREL diskette. (This file also is stored on the WORLDS diskette.)

- 3 Type **P21.WOR** and then press the  key. The Simulator displays the world, and this message is on your screen:

```
The Initial Situation has been successfully loaded. ←
```

Press the  key. This message appears on your screen:


The Simulator is ready to execute Karel's program. ←

Press the  key to start running the program you created for Problem #1.

This program does contain an error. It tells Karel to get a beeper on a corner where there is no beeper. As a result, Karel does an *error shutoff*. This message appears on your screen:


Error shutoff (pickbeeper): There is no beeper to pick up on this corner. ←

This message gives you an instruction and tells you what the error was.


4 Press the  key. This message appears on your screen:


Karel was executing line number 11. ←

The Simulator displays the number of the line containing the error, in this case, **line number 11**.

5 Press the  key again. This message appears on your screen:

The List of Currently Executing Defined Instructions:
In BEGINNING-OF-EXECUTION at 11

6 Press the  key again. The Simulator displays the entire program for you and highlights the line containing the error.


7 Press the  key once more. The world appears briefly. Then, you return to the Karel System Menu.

8 Now, type **E** to return to the Editor to correct the errors in the program for Problem #1.

Correcting Errors in Your Program







When you return to the Editor, this message appears on your screen:

Load Karel program from A:PROBLEM21.PRO (Yes or No)[Y]_

Press the  key. The Editor automatically reads the file and displays the program as you originally typed it. Refer to the textbook for hints about the errors in this program, then correct the program in order to successfully accomplish the task in the P21.WOR file.

You know that the error is on line 11, which instructs Karel to pick up a beeper. There is no beeper on that corner, so you have to move him one block west, turn him left, then move him one block south.

Here's how to do it:

- 1 Use the  key to move the cursor to line 11—**pickbeeper;**
- 2 Then, hold down the  key and press the  key three times to add blank lines to your program.
- 3 Use the  key to position the cursor on the first blank line.
- 4 Press the Spacebar four times to position the cursor under the **m** in *move*;
- 5 Type **move;** and then press the  key. The cursor moves to the next blank line.
- 6 Type **turnleft;** and then press the  key. The cursor moves to the last blank line.

7 Type **move**;

8 Now, press the **Alt** key and type **S** at the same time to save your corrected program. This message appears on your screen:

Save this Karel program in which file [A:PROBLEM21.PRO]:_

The Editor gives you the option of saving the corrected program in the original file that you used to create the program.

9 Press the **Enter** key to save the corrected program in the original file.

10 When you see the *Exit Option* message, type **S** to go to the Simulator. When the Simulator is started, press the **Enter** key to start the Simulator reading and displaying the corrected program. If there are any errors, return to the Editor, correct them, save them, and then return to the Simulator.

When the program is grammatically correct, the Simulator displays this message:

Karel's program contains no lexical or syntactic errors.←←

11 Press the **Enter** key to continue using the Simulator. Then, follow the directions on your screen to load the world (P21.WOR) and run your corrected program.

12 Repeat these steps as necessary to correct your program so that Karel can successfully accomplish his task.

When your program runs successfully, this message appears on your screen:

Karel executed a "turnoff". There were no execution errors.←←

13 Now, press the  key to return to the Karel System Menu.

There is a simpler solution to this problem which you may like to figure out. It involves adding just one **turnleft;** command earlier in the program, long before line 11. Adding this command lets Karel successfully accomplish his task.

Here are some hints for solving this problem:

1. Go to the Editor and load the file named **P21A.PRO**. This file is stored on the ANSWERS diskette, and it contains the *incorrect* version of the program.
2. After the program is displayed on your screen, try to reconstruct Karel's moves with this program.

Where could you add another **turnleft;** command so that Karel can reach the correct corner to pick up the beeper? Study the program for a few moments to see if you can figure it out.

3. Once you think you've got the answer, edit this file and then run it through the Simulator.

Note: If you're having trouble solving this program, the *correct* version of it is stored in a file named **P21B.PRO** on the ANSWERS diskette. The more you use Karel the Robot, the easier it will be for you to spot the solutions to this kind of programming problem.

Additional Practice with the Editor



For more practice with the Editor, use the program for Problem #2, which appears in Chapter Two of the textbook. Problem #2 contains several errors.

Remember: When you are asked for a filename for Problem #2, choose a name different from PROBLEM21.PRO so that the computer doesn't copy your new file over your old one. Use **PROBLEM22.PRO**.

Go back to the beginning of this section and repeat all of the steps up to the point where you see this message from the Simulator:

Karel's program contains no lexical or syntactic errors. ←



Refer to Chapter Two of the textbook for hints about the errors in Problem #2, then go back to the Editor and correct the program.

Because the purpose of Problem #2 is to help you learn how to spot your own lexical and syntactic errors, you are finished with this program when you see this message:

Karel's program contains no lexical or syntactic errors. ←

Then, press the Esc key to return to the Karel System Menu.

Before You Go On



Before going on to the next section of this Guide, go back to Chapter Two of the textbook, and write a program for two of these problems:

- Problem #4—*the newspaper retrieval task*

Use the world stored in the file named **P24.WOR** on the **WORLDS** diskette to make sure that your program runs correctly in the Simulator.

- Problem #5—*the mountain-climbing task*

Use the world stored in the file named **P25.WOR** on the **WORLDS** diskette to make sure that your program runs correctly in the Simulator.

- Problem #6—*the grocery pickup task*

Use the world stored in the file named **P26.WOR** on the **WORLDS** diskette to make sure that your program runs correctly in the Simulator.

When you finish writing your programs, use the Simulator to find and correct any errors, then try to run your robot programs to see what happens. Go back over the information in this section and in the textbook and then correct any errors so the programs run successfully.



Next, return to the textbook and read Chapter Three. Then, do Problem #5 and either Problem #2 or Problem #6 in Chapter Three. Use the worlds already saved on the WORLDS diskette:

- P32.WOR for Problem #2
- P35.WOR for Problem #5
- P36.WOR for Problem #6

Summary



If you want, try writing some of the programs for the other problems in Chapter Three of the textbook.

When you've successfully completed as many of the practice problems as you want to try, you are finished practicing with the Editor. Return to this Guide and go on to the next chapter, "The World Builder."

Chapter 6. The World Builder

Contents


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Practicing with the World Builder



Up to now, you've been given existing worlds in which to test your Karel programs. In this chapter, you'll practice using the World Builder to create your own *initial situations* (worlds) in which you can run the robot programs that you write.






You need six simple commands to build a world for Karel:

Move	[M]
Face	[F]
Build	[B]
Destroy	[D]
Load	[L]
Put	[P]

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the  key (if the Karel System is on).


Once the Karel System Menu is on your screen, you're ready to use the World Builder.

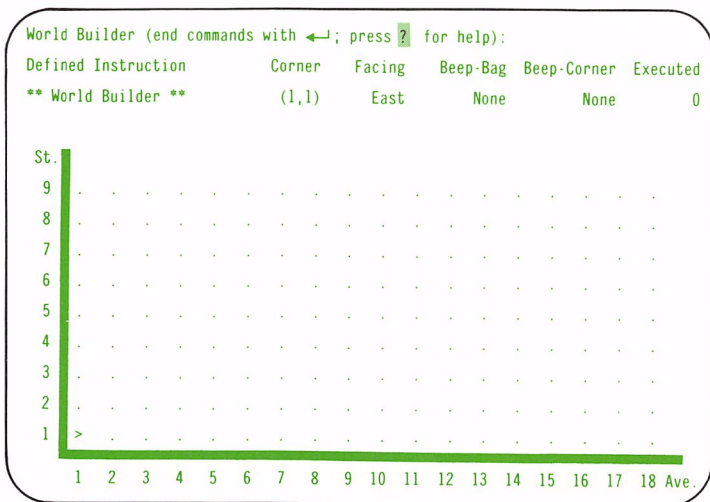
Note: For a brief explanation of the World Builder commands, just press the  key and the  key at the same time.

If you have a printer and you want a printed copy of this information, first display the help screen by pressing the  key and the  key at the same time. Finally, press the  key (or the  key if you have an IBM PC or an IBM PC XT) and the  key at the same time to print your information.

- 1 Type **W** to start the World Builder. After a few seconds, this message appears on your screen:

How do you want to start (Blank world or Existing world)[B]:_

- 2 Press the  key to start a blank world. A blank world appears on your screen, and Karel appears at the *origin* (the starting point in a blank world), the corner of 1st Street and 1st Avenue.



Let's build a world with the World Builder commands. First, the command is explained for you. Then, you type the command to build the world.

The Move Command

Use the *Move* command to move Karel around his world. Karel can move a space or two at a time, or he can move several blocks at once, with no stops in between.

Notes:

1. In the World Builder, you can move Karel through any wall sections you might build. This isn't true once the Simulator tries to run your program, however. Karel's program stops if Karel is instructed to move through a wall.
2. If you try to move Karel past either the west (left) or south (bottom) boundary wall, he stops at the corner nearest the boundary.
3. If you move Karel north or east and off the current screen, the display is erased and redrawn with Karel centered on the screen.

Here are some examples of different kinds of move commands:

Command	Result
---------	--------

M 4,9	Karel moves to the corner of 4th Street and 9th Avenue.
--------------	---

Remember: Separate the numbers with a comma.

M N 5	Karel moves north five blocks.
--------------	--------------------------------

M O	Karel moves to the origin and faces east (his usual starting position and direction).
------------	---



Karel moves to the origin and faces east.



Karel moves one block forward in the direction he is facing.



Karel moves one block north or south.



Karel moves one block west or east.


5	
----------	---

Karel moves five blocks forward in the direction he is facing.

-5 

Karel moves 5 blocks backward.


Let's move Karel to the corner of 1st Street and 5th Avenue.

Type **M 1,5** and then press the  key. Karel appears at his new location.

The Face Command


The *Face* command is an easy way to turn Karel in a different direction—north, south, east, or west. At the moment, he is still facing east at 1st Street and 5th Avenue.


Let's turn Karel around to face west.

Type **F W** and then press the  key. Karel quickly turns west.

The Build Command

The *Build* command lets you build walls in Karel's world. These walls are located halfway between corners. At the moment, Karel is facing west on the corner of 1st Street and 5th Avenue. Let's build one wall to the north and another to the east.

1 Type **B N** and then press the  key. A short wall appears just north of Karel.


2 Type **B E** and then press the  key. A wall appears behind Karel to the east.

Note: You also can build both walls with a single command: **B N E**.

The Destroy Command

You can *Destroy* walls that you build in a world. Right now, Karel is facing west on the corner of 1st Street and 5th Avenue. There are walls to his north and east.

Let's destroy the east wall.

Type **D E** and then press the  key. The east wall disappears.

The Load Command

Karel has a *beeperbag* in which he can carry up to 32,000 beepers. You can have Karel load beepers into his beeperbag, then you can tell him to put down these beepers as he moves through his world.


The *Load* command lets you load these beepers into Karel's beeperbag. If you try to load a number larger than 32,000, only 32,000 are loaded.

You can tell how many beepers Karel has by looking at the BEEP-BAG heading on the second line of the screen.

Remember: This command doesn't add beepers to the beeperbag. It just loads the number of beepers indicated by the number you type in the command.

For example, if Karel has 10 beepers in his bag and you tell him to load one beeper, Karel ends up with one beeper in his bag, not 11 beepers.


Let's load five beepers into Karel's beeperbag.


Type **L 5** and then press the  key. The number **5** appears under the BEEP-BAG heading.

The Put Command

Use the *Put* command to put beepers on corners in the world.

Let's put three beepers at Karel's present location, the corner of 1st Street and 5th Avenue.

Type **P 3** and then press the  key. The number 3 appears under the Beep-Corner heading.

Note: You can't see the beepers on this corner because Karel already is standing there. To move Karel off his corner so you can see the beepers, press the  key.

Advanced Use of World Builder Commands

Three of the World Builder commands—Build, Destroy, and Put—let you create more complex worlds with fewer commands.

For example, the simple command **BN** builds a wall to the north of Karel. The command **BN5E** builds a wall to the north of Karel for five blocks heading east.




The simple command **P2** puts two beepers on Karel's current corner. The command **P2N3** puts two beepers on Karel's current corner, moves him north, puts two beepers on his new corner, moves him north again, and puts two beepers on his next corner.

Now, spend some time practicing with the World Builder commands. When you feel ready to build your own initial situations, go on to the next section, "Leaving the World Builder."

Leaving the World Builder

There are two ways you can leave the World Builder when you are through building a world:

- *Save* your current world in a file


Note: If you have a printer, you can print a copy of the world you've built before you save it. Press the  key (or the  key if you have an IBM PC or an IBM PC XT) and the  key at the same time. A copy of the current world is printed for you.

- *Quit* the World Builder before deciding whether to save the current world

The *Save* command (S) saves your current world in a file that you specify. Then, it exits the World Builder and returns you to the Karel System Menu.

The *Quit* command (Q) exits the World Builder without automatically saving the current world. Then, you choose whether to save your current world.

There is no need to save the practice world you just created, so you can quit the World Builder:

- 1 Type **Q** and then press the  key. This message appears on your screen:


Do you want to save this file on diskette (Yes or No)[Y]:_

- 2 Type **N** to return to the Karel System Menu.

Creating a World




Now, turn to Problem #5 in Chapter Three of the textbook (and either Problem #2 or Problem #6, whichever one you chose as your second practice problem using the Editor). Let's use the World Builder to create a new world for each of these problems.

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the  key (if the Karel System is on).

Once the Karel System Menu is on your screen, you're ready to use the World Builder:

- 1 Type **W** to start the World Builder. This message appears on your screen:

How do you want to start (Blank world or Existing world)[B]:_


- 2 Press the  key to start a blank world. This blank world appears just as it did in the practice session using the World Builder.






For this exercise, build a world like the one shown for Problem #5 in the textbook, with one important difference—*reconstruct the world one block north of its present location*. Include all beepers and Karel's new starting position.

Follow these steps to get started:



- 1 Use the Move command to take Karel from the origin, 1st Street and 1st Avenue, to 2nd Street and 6th Avenue.

Type **M 2,6** and then press the  key. Karel moves to the correct starting position for the world you are building.

Next, use the Face command to turn Karel north.

- 2 Type **F N** and then press the  key.
- 3 Press the  key or the  key to move Karel forward to the corner of 3rd Street and 6th Avenue.

Use the Put command to put one beeper on Karel's present corner.

- 4 Type **P 1** and then press the  key.
- 5 Press the  key to move Karel off his present corner and show the beeper. The number **1** appears on the corner of 3rd Street and 6th Avenue.




- 6 Continue to put beepers in the world until it looks like the one in Problem #5 in Chapter Three.

Remember: Your world starts one block north (on 3rd Street and 6th Avenue) and ends on 9th Street and 6th Avenue.


- 7 When you finish putting beepers in the world, move Karel to the corner where he must be at the *start* of the initial situation (2nd Street and 6th Avenue), then face him north.

Note: Karel always starts his task at the corner he occupies when you *exit* the World Builder. Therefore, if you don't put Karel on the right corner before you leave the World Builder, he won't be able to perform his task correctly in the Simulator.

Now, save this new world.

- 8** Type **S** and then press the  key. This message appears on your screen:

Save this initial situation in which file: _

- 9** Type the filename you want to use for this world, and then press the  key. The World Builder saves your world, and you return to the Karel System Menu.

- 10** Type **S** on the Karel System Menu to start the Simulator, then follow the steps in "Chapter 4. The Simulator—The First Time" to run your program in the new world you just created.

When you're finished, go to the next section of this chapter, "Modifying an Existing World."

Remember: Type the filenames that you gave to the program and world *for the problem you are working on* instead of the practice names that appear in the Simulator practice steps.


Modifying an Existing World

Follow the steps in this section whenever you want to *modify* (make changes to) an existing world:


- 1 Type **W** on the Karel System Menu to start the World Builder.

In response to your request to begin with an existing situation, the World Builder displays this message:


Enter the name of the file containing the initial situation: _


- 2 Type the filename and then press the  key. The World Builder draws the initial situation on the screen.

- 3 Use the World Builder commands to make any changes.

- 4 Press **S** to save your modified initial situation. Then, press the  key. The World Builder displays this message:

Enter the filename in which to save the initial situation [current filename]: _

If you want to save the modified world in *the existing file*, press the  key.

If you want to save the modified world in *a new file*, type that filename and then press the  key.

After the file is saved, you return to the Karel System Menu.

Practice Problems



Now, go back to "Creating a World" earlier in this chapter, and build a world for either Problem #2 or Problem #6, whichever one you chose to write a program for in Chapter 5 of this Guide. Remember to reconstruct the initial situation one block north of its present starting location.

When the Simulator finishes running your programs and there are no errors, try some further practice with the World Builder. Here is another practice problem for you to try:



- 1** Review the example initial situation shown in figure 3-2 of the textbook, as well as the complete program shown in the textbook.
- 2** Follow the steps in "Chapter Five. The Editor," and type the program exactly as shown in the textbook.
- 3** Now, create a new world for this program. Use all of the information you've learned so far to try something different.
- 4** Save your new world on a diskette.
- 5** Use the Simulator to check the accuracy of your program and correct any errors.

Summary

When you have successfully completed these practice problems, you are through practicing with the World Builder, so turn to the next chapter of this Guide, "The File Manager."

Chapter 7. The File Manager

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Reference Information

The File Manager provides a convenient way to do five important tasks:

- List the files on a diskette
- Rename a file
- Copy one or more files from one diskette to another
- Delete a file from a diskette
- Format a blank diskette

File Manager Commands

These are the File Manager commands:


Command	Result
L	Lists the filenames on a diskette
R	Renames file(s) on a diskette
C	Copies file(s) from one diskette to another (or to the printer)
D	Deletes file(s) on a diskette
F	Formats a new diskette for use with the Karel System
Q	Quits the File Manager; returns to the Karel System Menu

Let's look at the Copy and Delete commands in more detail.

The Copy Command

When you select the Copy command, you must specify a diskette drive (A or B) where the program looks for the diskette with the file you want to copy. This next message appears on your screen:

Copy file(s) TO the diskette in drive (A, B, Printer, or Cancel)[A]:_

- 1 *If you have a single-drive system, press the  key to use drive A.*


*If you have a dual-drive system, type **B** to use drive B.*

Note: You can print a copy of any file by typing **P** in response to this message.

Next, you see this message:

Put into drive A the diskette containing the file(s) to be copied. ←



- 2 Remove your KAREL diskette from drive A and insert the *source* diskette (the one you want to copy from) in drive A.

- 3 Press the  key.

This next message appears:


Copy which file (* ← = all files; press ← to quit Copy):_

This message gives you three choices:

- Copy the file you want by typing the filename where the cursor is blinking. Then, press the  key.
- Copy all the files on the diskette in the drive you specified by typing * and then pressing the  key.

- Quit the Copy operation by pressing the  key.

Copying All Files

To copy all of your files, type * and then press the  key. This message appears on your screen:

Copy all files from this diskette (Yes, Ask individually, or No)[N]:_

- *If you type Y*, you see this message:

Copying all files on the (diskettename) in drive A

The message specifies the drive you selected earlier. The file named as the default in the message is copied. You see several brief messages on your screen.

When copying is complete, remove both diskettes.

- *If you type A*, the File Manager prompts you individually for each file saved on the source diskette. You see this message for each file:

Confirm copying of (filename) (Yes or No)[N]:_

- *If you type N*, the program skips the file and asks you about the next one. After you are asked about all files, you see this message again:

Copy which file (*← = all files; press ← to quit Copy):_

- Press the  key to quit the Copy operation.




The Delete Command

When you select the Delete command, you must specify a diskette drive (A or B) where the program looks for the diskette which contains the file you want to delete.

You see this message:

```
Delete which file (*← = all files; press ← to quit Delete):_
```


This message gives you three choices:

- Delete one particular file by typing the filename where the cursor is blinking and pressing the  key.
- Delete all files on the diskette by typing * and then pressing the  key.
- Quit the Delete operation by just pressing the  key.

Remember: Deleting a file cannot be undone. Therefore, it is important that you be careful when working with the Delete command.

To be safe, you are given a chance to confirm that you want to delete a certain file or files *before* the program actually does the deletion.

Deleting All Files

To delete all files, type * and then press the  key. This message appears on your screen:

```
Delete all files on this diskette (Yes, Ask individually, No)[N]:_
```

- *If you type Y, you see this message:*

```
Confirm deletion of ALL files (Yes or No)[N]:_
```

- *If you type A*, you see this message for each file:


Confirm deletion of (filename) (Yes or No)[N]:_

To delete this file, type **Y** again. This message appears on your screen:


Delete successful; (filename) deleted.

Then, the list of files on the screen is updated. Check this list to be sure the filename you just deleted is no longer listed. *If you type N*, the program skips the file and asks you about the next one. After you are asked about all files, you see this message again:

Delete which file (*← = all files; press ← to quit Delete):_

To quit the Delete operation, press the  key.

Practicing with the File Manager

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the  key (if the Karel System is on).

Once the Karel System Menu is on your screen, type **F** to start the File Manager. After a few seconds, this screen appears:

```
File Manager (List, Rename, Copy, Delete, Format, Quit or ?)[Q]:_
```

```
Files currently on the Karel diskette in drive A:
```

```
BEEPTRANS.PRO
```

```
BEEPTRANS.WOR
```

```
P21.WOR
```

Note: Any other practice files that you created also appear on this screen.

Now, look at the list of files on your screen to make sure that the BEEPTRANS.PRO file is on your Karel diskette in drive A. This is the file you use in this section.


If, for some reason, the file is not there, choose any one of your practice files that ends with **.PRO** to use in this section. Then, whenever you are asked to type BEEPTRANS.PRO, just type this filename instead.

Renaming a File


Let's practice renaming a file.

- 1 Type **R**. This message appears on your screen:

Rename file(s) on the diskette in drive (A, B, or Cancel)[A]:_

- 2 Your practice file is stored on the diskette in drive A, so just press the  key. This next message appears on your screen:

Enter old file name (press  to quit Rename):_

- 3 Type **BEEPTRANS.PRO** and then press the  key. This third message appears on your screen:

Enter new file name (press  to quit Rename):_


You need to type the new name for this file.
Let's call it **TEMPBEEP.PRO**.

- 4 Type **TEMPBEEP.PRO** and press the  key. This last message appears on your screen:

Rename successful; file BEEPTRANS.PRO is now TEMPBEEP.PRO.

The File Manager then asks for more files to rename:

Enter old file name (press  to quit Rename):_


Since you don't want to rename any more files, press the  key to end the Rename operation and display the File Manager options.

Copying a File


Next, let's practice copying a file.

- 1 Type C. This message appears on your screen:


Copy file(s) FROM the diskette in drive (A, B, or Cancel)[A]:_

- 2 Press the  key to copy a file *from* drive A. This message appears on your screen:

Copy files(s) TO the diskette in drive (A, B, Printer or Cancel)[A]:_

- 3 Press the  key to copy a file *to* drive A. This third message appears on your screen:


Put into drive A the diskette containing the file(s) to be copied. 

- 4 This diskette already is in drive A, so just press the  key. This fourth message appears on your screen:


Copy which file (* = all files; press  to quit Copy):_

This message gives you three choices:


- Copy only the TEMPBEEP.PRO file
- Copy all files on the diskette
- Quit the Copy operation

- 5 To continue practicing, type **TEMPBEEP.PRO** and press the  key. This fifth message appears on your screen:

Put into drive A the diskette that is to contain the copied file(s). 


- 6 Your KAREL diskette still is in drive A, which is where the file is to be copied, so just press the  key. This message appears next:

Enter file name for new copy [TEMPBEEP.PRO]:_

7 Type **BEEPTRANS.PRO** and then press the  key. You see several messages as the File Manager copies the file.

8 When copying is complete, you see this message:

Copy which file (*← = all files; press ← to quit Copy):_


Press the  key to quit the Copy operation and return to the File Manager options.

Deleting a File

Finally, let's practice deleting a file.

1 Type **D**. This message appears on your screen:


Delete file(s) on the diskette in drive (A, B, or Cancel)[A]:_

2 Press the  key to begin deleting the **TEMPBEEP.PRO** file. This message appears next:

Delete which file (*← = all files; press ← to quit Delete):_

This message gives you three choices:

- Delete the file named **TEMPBEEP.PRO**
- Delete all the files on the diskette in drive A
- Quit the Delete operation

3 Type **TEMPBEEP.PRO** and press the  key to delete this file. This third message appears on your screen:

Confirm deletion of A:TEMPBEEP.PRO (Yes or No)[N]:_


This message is here to keep you from accidentally deleting a file. It lets you make sure that you really want to delete the file you specified. If you don't, you can escape from the Delete operation.

- 4 Type **Y** to delete this file. This last message appears on your screen:

Delete successful A:TEMPBEEP.PRO deleted

When the file is deleted, this message appears on your screen:

Delete which file (*← = all files; press ← to quit Delete):

- 5 Since you don't need to delete any more files, just press the  key. You return to the File Manager options.

Listing Files




Let's look at a listing of the files on a diskette.

- 1 Type **L** to see this message:

List the file names on the diskette in drive (A, B, or Cancel)[A]:_

- 2 Type the letter of the drive that contains the diskette whose contents you want to list.

A listing of the files on that diskette is displayed on the screen.

Note: You can print a copy of this listing (if you have a printer) by pressing the  key (or the  key if you have an IBM PC or an IBM PC XT) and the  key at the same time.

Formatting Blank Diskettes

To format blank diskettes, follow this procedure:

- 1 Type F. This message appears on your screen:


The diskette is to be formatted in drive (A, B, Cancel)[A]:_

- 2 *If you have a single-drive system*, press the  key.

If you have a dual-drive system, type **B**.

This message appears next:

Enter name for new diskette (7 or fewer letters)[BACKUP1]:_


- 3 Type a filename of seven letters or fewer, and then press the  key. A third message appears on your screen:

Put into drive A the diskette to be formatted.↵


Note: If you specified drive B above, drive B is named in this message.

- 4 *If you have a single-drive system*, remove your Karel diskette from drive A, and insert a blank diskette in drive A.

If you have a dual-drive system, insert a blank diskette in drive B.

- 5 Press the  key. This message appears on your screen:

Enter final Format Command (Format or Cancel)[F]:_

- 6 Press the  key.

- 7 *If you have a single-drive system, this message appears when formatting is complete:*

Please put the KAREL diskette into drive A. ←

Remove your formatted diskette from drive A, and insert your KAREL diskette in this drive.

Remember: Label your new formatted diskette with the name you just gave it.

- 8 Type Q to Quit the File Manager and return to the Karel System Menu.

Summary

This concludes your practice session with the File Manager. There are no problems from the textbook to use for further practice in this section.

Now that you've practiced using each part of the Karel System, go on to "Chapter 8. The Textbook."

Chapter 8. The Textbook

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8-2


Reconfiguring Your System


At this point, you've practiced using all of the parts of the Karel System, and you should be familiar with the way each of these parts works.

This chapter of the Guide relates to Chapters Four, Five, and Six of the textbook, and you'll be working on some of the problems in these chapters.

First, you need to *reconfigure* (change) your system from **Beginner** mode to **Experienced** mode. The main differences between Beginner mode and Experienced mode are these:

- In Beginner mode, some options are not displayed. For example, the Execution options (mode, speed, type of display) are pre-set in Beginner mode. Also, worlds must be built before entering the Simulator, because you don't have the option of going to the World Builder from the Simulator in Beginner mode.
- In Experienced mode, you see all Simulator options and can choose your response to each one. Also, you can type several responses one after another, without waiting for option messages to appear.
- In Experienced mode, you can enter the World Builder directly from the Simulator, so you can test a robot program in different worlds without having the Simulator check it for grammatical errors each time.

At the moment, the Karel System Menu should be on your screen. If it is not, either start the program again (if your computer is off) or press the  key (if the Karel System is on).

Once the Karel System Menu is on your screen, type **C** to start the Configurer. Then, press the  key until this message appears on your screen:

User Level (Beginner or Experienced) [B]:_

Type **E** to change the User Level to Experienced mode. Then, continue through the rest of the Configurer options, either changing them or leaving them the same.

When you are through configuring your system, refer to "Formatting Blank Diskettes" in Chapter 7 to format at least one blank diskette. Always keep a blank formatted diskette available for extra storage space.

Simulator Modes

When you use the Simulator after reconfiguring your Karel System for Experienced mode, you see some messages offering you several choices.

There are three *modes*, or ways, in which you can run the Simulator:

Automatic mode

Runs your program without any action on your part. This is how all programs run at the Beginner level.

Monitor mode

Lets you tell the Simulator how many instructions you want to execute at a time and whether you want to go forward or backward (in order to recheck an instruction).

Explain mode

Gives a detailed description of how Karel executes your program. It moves only at slow speed and executes a single instruction at a time.

The Simulator also gives you a choice of three speeds that Karel can use to execute your program instructions--**fast**, **medium**, and **slow**. Beginner mode runs at medium speed. In Experienced mode, you can choose the speed that seems most comfortable for you (except that Explain mode only runs at slow speed).

The third type of message the Simulator shows you asks if you want to use **Regular** or **Sticky** mode. In Sticky mode, Karel "leaves tracks" (images of himself) on each corner he passes. This makes it easy for you to see where Karel has been. If, however, he passes the same corner more than once, only the image of his last move is visible. Beginner level runs in regular mode, so Karel's tracks don't appear.

Conditionally Executing Instructions



Go to the textbook and carefully read Chapter Four. Pay special attention to these terms, because you'll be using them throughout the rest of this course:

IF/THEN Instruction
program fragment

THEN clause
DEFINE-NEW-
INSTRUCTION

IF/THEN/ELSE Instruction
nested IF Instructions
test reversal
top factoring
dangling ELSE

ELSE clause
execution equivalent
bottom factoring
redundant-test factoring

When you complete your reading, return to this Guide and follow these steps to complete Problem #6—the *steeple-chase task*—in Chapter Four of the textbook.

- 1 Use the Editor to write a program that lets Karel perform the task in all of the legal worlds, one of which is shown in Figure 4-4 of the textbook.

Remember: Save your program before you leave the Editor.

- 2 Test your program by running it on the Simulator using the world already saved in the P46.WOR file on your WORLDS diskette.

Note: There also are two alternative initial situations stored in P46A.WOR and P46B.WOR on the WORLDS diskette. Test your programs on these worlds, too.

If the Simulator finds any errors in your program, be sure to correct them.

- 3 Use the World Builder to create several new worlds in which Karel can perform the task.

Remember: Before you save each world, move Karel to the corner where he must be when he starts the initial situation and face him in the correct direction.

As you complete each world, save it so that you can use it in the rest of this practice.

- 4 Use the Simulator to have Karel try to perform his task in each of your new worlds.

Correct any errors that the Simulator may find.



For additional practice, follow these steps to complete Problem #9—the *follow-wall-right task*—in Chapter Four of the textbook:

- 1 Write a program that allows Karel to correctly make each of the four moves, then save each program.
- 2 Use the World Builder to recreate the four walls shown in Problem #9. Save each world after you build it.
- 3 Use the Simulator to have Karel try to perform his task in each of your new worlds.

Correct any errors that the Simulator may find.

Instructions that Repeat



Go to the textbook and carefully read Chapter Five. Pay special attention to these terms, because you'll be using them throughout the rest of this course:

ITERATE Instruction

WHILE Instruction

infinite loop

beyond-the-horizon situation

ITERATE loop

WHILE loop

stepwise refinement

When you are finished reading, complete any one of the bulleted problems in Chapter Five of the textbook.

Then, return to this Guide, and use the Simulator to check and run your program to see if you've solved it correctly. Correct any errors if necessary.

Advanced Robot Programming



Go to the textbook and carefully read Chapter Six. Pay special attention to these terms, because you'll be using them throughout the rest of this course:

preconditions
answer corner

question corner

Summary

At this point, you should have a fairly good understanding of structured programming and how to write your own structured programs.

Now, refer to Chapter 9 for detailed information about using the Simulator for advanced robot programming and debugging.

Chapter 9. The Simulator—Advanced Use

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Reference Information

This chapter gives you detailed information about using the Simulator for advanced programming and debugging.

Stopping the Simulator Temporarily

Whenever you are using the Simulator, you can stop it temporarily. At the point where you want to stop the Simulator, quickly press the  key, and then press the  key and type N at the same time.

Note: If you have an IBM PC or an IBM PC XT, quickly press the  key and the  key at the same time.

When you are ready to continue, press any key. The Simulator starts running where it left off.

This process can be repeated as often as necessary. While the Simulator is stopped, the information displayed does not move or change. You cannot make any changes to the contents after you stop the Simulator.

Working with Large Robot Programs

The Simulator does not run more than 2,500 instructions within any one Karel program. This is quite a large number of instructions, considering that most programs run fewer than 1,000 instructions (even in large initial situations). If a Karel program tries to do more than the maximum 2,500 instructions, the Simulator automatically forces Karel to do a turnoff. At this point, you are asked to choose a Post-Execution option.

It may be a while before you begin writing very large robot programs (more than 200 lines). Be aware,

however, that when the Simulator attempts to execute a very large program, performance (the speed at which the system does its job) may drop dramatically. Should this occur, press the **Esc** key to cancel the Simulator operation and return to the Karel System Menu.

In general, to overcome the problem of too many instructions, try to reduce the size of your Karel program, or test it in a simpler initial situation.

Printing Errors and Error Messages

When the Simulator checks your robot program and displays it with comments, you might want to print the part of the screen that shows the errors and error messages.

To do this, when an error and it's supporting message(s) are printed on the screen, just press the **Fn** key (or the **⇧** key if you have an IBM PC or an IBM PC XT) and the **PrintSc** key at the same time.

Continue to do this every time an error and it's message(s) appear. When the Simulator finishes displaying the program, you have a printed copy of all errors that need to be corrected.



Here is the listing that the Simulator displayed for an incorrect version of *the stair-cleaning task* from Chapter Three of the textbook. The comments point out both lexical and syntactic errors.

Line Number	BEGIN/END Nesting	Program Text
1		BEGINNING-OF-PROGRAM
2		
3		DEFINE-NEW-INSTRUCTION turnright AS
4		BEGIN
5	1	turnleft;
6	1	turnleft;
7	1	turnleft
8		END;
9		
10		DEFINE-NEW-INSTRUCTION climb-stair AS
11		BEGIN
12	1	turnleft;
13	1	move;
14	1	turnroght
		↑ ***PROBLEM***

Lexical Error:

I'll assume that you misspelled: "turnright".
You wrote: "turnroght".

14	1	turnroght;
15	1	move;
16		END;
17		
18		
19		BEGINNING-OF-EXECUTION
20	1	climb-stair;
21	1	pickbeeper
		↑ ***PROBLEM***
22	1	climb-stair

Syntax Error:

Instructions in a block must be separated by semicolons.
This program also contains at least 1 misspelling(s).

Compilation cancelled; Edit the program and rerun the Simulator.

Options (Karel System Menu or Editor)[E]:

The line numbers in the program are used by Explain mode (and Monitor mode at Slow speed) to tell you information about your robot program. These line numbers also serve as a reference point when you change or correct the program in the Editor. In the Simulator, this message may appear in Explain mode:

Ready to execute the "turnleft" instruction (Line=12).

The (**Line= 12**) notation means the instruction on line 12 is about to be executed. If you have the same instruction on several lines, this helps pinpoint where in your program the Simulator is at any given moment.

The counting of BEGIN/END-block nesting levels shows you which BEGIN matches which END. Every instruction between a BEGIN and an END has a nesting level one (1) higher than that of the enclosing BEGIN and END reserved words.

Note: See the next example program that shows the program instructions with a nesting level of **1**, while the surrounding BEGIN and END words have a nesting level of **0** (blank).

Annotated Karel Program:

Line Number	BEGIN/END Nesting	Program Text
1		BEGINNING-OF-PROGRAM
2		
3		DEFINE-NEW-INSTRUCTION turnright AS
4		BEGIN
5	1	turnleft;
6	1	turnleft;
7	1	turnleft
8		END;
9		

If you are having trouble matching BEGIN/END blocks, start looking for the solution to your program bug by checking the nesting levels.

The Simulator temporarily ignores misspellings in instruction names and reserved words. Each time the Simulator detects a spelling error, it displays a warning message. Then, it continues reading the program.

The Simulator does not run a program, however, unless every word is spelled correctly. So, if a program contains any spelling errors, you must correct them, then rerun the Simulator.

Finally, the Simulator stops after the first error other than a simple misspelling. Look at the error message, make the necessary corrections in your program, then rerun the Simulator. To save time while you're correcting the error the Simulator spotted, quickly review your entire program for similar lexical or syntactic errors.

Monitor Mode Commands

The commands listed below also are shown on the Help screen in Monitor mode. You can see them just by pressing the **Shift** key and the **[/?]** key at the same time.

Each Monitor mode command has three parts. The sequence in which you use these parts is important.

- Execution speed— Fast, Medium, or Slow
- Execution Direction— + for forward, - for backward
- Number of instructions to execute or step (the default is always 1 instruction), or a command from this list:

Command	Result
B	Backs up execution to the beginning of the program
C	Configures the Simulator
D	Displays the defined instructions that are currently executing
E	Continues execution to the end of the program
I	Traces inside the instruction name specified

L	Looks at a portion of the world
O	Changes the Execution options
P	Prints (on your display) the definition of a specified defined instruction
Q	Quits the program (Some instructions may be executed first.)
T	Traces to the next occurrence of the instruction name specified
U	Undoes instruction tracing (cancels the I command)

If any part is omitted, its default value (displayed on the screen within square brackets []), is used.

Note: The defaults for speed and direction are those you used the last time you responded to the Monitor mode stepping message. The default number of steps is always 1, regardless of the number you entered the last time you responded to the stepping message.

If you type only a letter command, it executes at the default speed and in the default direction.

Simple Stepping in Monitor Mode

The ability to vary the way you execute a robot program is called *stepping* because you literally can step through your program one or more instructions at a time.

When you use Monitor mode to run a program in the Simulator, after an instruction executes, you can change any of the program options by simply using different Monitor mode commands. For example, you might decide to do one or more things:

- Readjust Karel's Execution speed.
- Decide that Karel should change the direction in which he is executing the program.
- Tell the Simulator to execute a certain number of instructions before it displays another stepping message.


The Stepping Message

Along with selecting Monitor mode as the Execution option, you also select the speed and display mode. These choices appear as the default when this stepping message appears at the top of your screen:

```
Ready to step forward (press ? for help)[F+1]:_
```

Execution Speed

Notice that the default stepping command shown at the end of the example message above is: **Fast, Forward, 1 instruction**, which is indicated by [F+1].

When you use the default values displayed on the screen (by pressing the  key) the program executes one (1) step in the default direction at the default speed. This is the most frequently used stepping command.

Monitor mode is the only Execution mode that lets you alter the way your program runs by changing speed and direction while the program is running. If only a speed or direction change is made, the defaults change on the screen, but Karel does not do (or undo) any instructions. In other words, nothing happens unless you also tell the Simulator the number of steps you want executed as part of the stepping command.

Execution Direction

In Monitor mode, you easily can change the direction of execution from the default (*forward*) to *backward*, and then to forward again.

Running a program backward is a useful feature. For example, assume that you are running a program forward a few instructions at a time and suddenly find that something is wrong—the program does not do what you expect it to do. You quickly can run the program backward a few steps to get Karel into a correct position. Then, you can run the program forward slowly (perhaps in Explain mode), until you find the instruction(s) that caused the error.

Number of Instructions to Execute

The third part of the stepping command is a number that tells the Simulator how many instructions to execute before displaying another stepping message. The default is always 1. If you enter a number, the Simulator steps through that many instructions and then returns to the default of 1 step.

If you ask the Simulator to step a large number of instructions, this message appears at the top of your screen:

Executing a large number of instructions...(press any key to interrupt)

This lets you change your mind and stop the Simulator. Just press any key to do this. If you are in Automatic or Monitor mode, you return to Monitor mode; if you are in Explain mode, you return to Explain mode.

Examples of Stepping Commands

This list contains examples and explanations of simple Monitor mode stepping commands.

Command	Result
---------	--------

F+5	Changes to Fast speed and executes forward a total of 5 instructions. (Remember, + = forward, - = backward.)
------------	---

M-	Changes to Medium speed backward but doesn't actually undo any instructions unless you also include a number to indicate how many instructions you want to "undo."
-----------	--

-15	Runs 15 instructions backward at the current speed.
------------	---

The next three examples show how the letters B, E, and Q are used in Monitor mode commands.

Remember: **B** means step to the beginning, **E** means step to the end, and **Q** means quit.

Command	Result
---------	--------

FB	Runs the program at Fast speed backward until it reaches the beginning (the initial situation).
-----------	---

E	Runs the program at the current default speed (forward) until it reaches the end (the final situation). This is the same as running the program in Automatic mode at the current default speed.
----------	---

Q	Quits running the program, then asks you to choose Post-Execution options. The Simulator may continue a bit before it actually quits.
----------	---

Whenever you use one of the three letter commands, you cannot alter Karel's behavior until after the Simulator finishes executing that command.

These commands can be used in both Monitor and Explain modes.

Command	Result
----------------	---------------

P	Prints (on your screen) the definition of any defined instruction in Karel's program.
----------	---

You can specify which instruction to print by typing its name, or you can use the default instruction name. In this case, the Simulator prints the defined instruction that Karel currently is doing.

If you do use the default instruction name, the currently running instruction is highlighted.

Before the Simulator displays the Monitor mode (or Explain mode) message, the Simulator allows you to print as many instruction definitions as you want.

D	Displays the list of all defined instructions that Karel is currently doing.
----------	--

This list always starts with "BEGINNING-OF-EXECUTION" and grows downward until it reaches the currently executing defined instruction. The current line number in each defined instruction is printed after the current instruction name.

L	Looks at various parts of Karel's world that are not displayed on your screen at the moment.
----------	--

This command also is used as a Post-Execution option. Refer to "Post-Execution Options" for details.

O Changes any one of the three Execution options (Execution mode, Execution speed, or Display mode) while you are in Monitor mode or Explain mode.

This lets you switch easily from Monitor mode to Automatic mode or Explain mode.

T Traces to an instruction.

This is a complex command and is discussed in the next section, "Advanced Debugging in Monitor Mode."

I Traces inside an instruction.

This is a complex command and is discussed in the next section, "Advanced Debugging in Monitor Mode."

Advanced Debugging in Monitor Mode

This section discusses the *tracing to* (T) and the *tracing inside* (I) commands (including the *undo* (U) command that works with the I command).

These three commands provide a powerful alternative to single-stepping through a program *x* number of primitive instructions at a time.

Note: Remember from your reading in Chapter Two of the textbook that *primitive* instructions are move, turnleft, pickbeeper, putbeeper, and turnoff. These are the five basic instructions Karel understands.

Now, using appropriate combinations of T, I, and U commands, any defined instruction can be quickly reached and tested. A *defined instruction* is one that you create using one or more of the primitive instructions.

This section also explains a debugging method that quickly allows you to locate your programming errors. This method is called *stepwise debugging*. It is related to the process of *stepwise refinement*, which is discussed in the textbook as one simple program construction method.

Using stepwise debugging, you quickly can survey how a program is running. A defined instruction is examined in detail only after you know that it contains a bug.

It takes some practice to use the T, I, and U commands effectively, but learning to do so can increase your debugging efficiency.

Tracing to an Instruction

The *trace to* (T) command is followed by one of Karel's instruction names. (You can trace to either a primitive or a defined instruction.)

The T command takes control from the Monitor mode stepping mechanism and automatically runs your Karel program (in the specified or default direction) until the specified instruction name is about to be executed.

If the program already is running inside the named instruction, the trace command runs your program until the end of that instruction is reached. Therefore, you easily can run your program up to any primitive instruction, or you can run it to the beginning or the end of any defined instruction.

When the Simulator finds the named instruction, control returns to the stepping mechanism in Monitor mode.

Tracing Inside an Instruction

The *trace inside* (I) command is followed by the name of one of Karel's defined instructions. (The reserved word "BEGINNING-OF-EXECUTION" is especially useful in this command, and it is the first default name.)

The I command takes control from the Monitor mode stepping mechanism and automatically steps to completion each instruction within the defined instruction that is being traced.

One restriction on the I command is that it can be used only after the Simulator starts running the defined instruction that is to be instruction-traced.


Notes:

1. All defined instructions that you trace appear on the instruction list displayed whenever you use the Display command.
2. The currently executing instruction appears on Karel's status line.

The *undo* (U) command interrupts and cancels the previously issued I command.

Stepwise Debugging

This section includes the information you need in order to *stepwise debug* a program. Also included is a sample program that shows you how stepwise debugging works.

- 1 First, use the **I** command in the "BEGINNING-OF-EXECUTION" block.
- 2 Each time you press the  key, the Simulator runs the next instruction in the "BEGINNING-OF-EXECUTION" block.
- 3 If a defined instruction does not run correctly (because of an execution or intent error), change the direction to *backward*. Then, completely undo the incorrect instruction.
- 4 Now, use the **U** command to cancel the **I** command.
- 5 Then, *step forward* one instruction in Monitor mode (to get inside the incorrect instruction).
- 6 Finally, use the **I** command again, this time inside the incorrectly executing instruction.
- 7 Repeat this stepwise debugging process until you find the exact location of your program bug.

To help explain how the **I** command works, let's explore an example.

Sample Program



Suppose that you are debugging *the room-escape task* listed in Chapter Five of the textbook. The "BEGINNING-OF-EXECUTION" block in that program contains these five instructions:

```
BEGINNING-OF-EXECUTION
go-to-wall;
turnleft;
follow-until-right-door;
exit-door;
turnoff
END-OF-EXECUTION
```

Now, suppose that you are stepping in Monitor mode at the beginning of this program. You see this message:


```
Ready To step forward (press ? for help)[F+]:_
```

- 1 To start instruction-tracing within the "BEGINNING-OF-EXECUTION" block, type **I BEGINNING-OF-EXECUTION**

The Simulator responds with this message:

```
Ready to execute "go-to-wall" in "BEGINNING-OF-EXECUTION" [F+]:_
```


This message indicates that you are tracing the instructions inside the "BEGINNING-OF-EXECUTION" block at the Fast speed in the *forward* direction, **[F+]**.

- 2 Press the  key. The defined instruction *go-to-wall* is run completely.

This action is different from stepping in Monitor mode, where the defined instruction *go-to-wall* is entered but not fully run. In Monitor mode, it takes several steps to completely do the *go-to-wall* instruction. The I command automatically runs the correct number of steps needed to reach the end of this instruction.


After running *go-to-wall*, the Simulator displays this message:

Ready to execute "turnleft" in "BEGINNING-OF-EXECUTION" [F+]:_

- 3 Press the  key again.

The primitive instruction *turnleft* is run. The Simulator then responds with this message:


Ready to execute "follow-until-right-door" in "BEGINNING-OF-EXECUTION" [F+]:_

- 4 Press the  key once more.

The next defined instruction, *follow-until-right-door*, is run completely. This message appears:


Ready to execute "exit-door" in "BEGINNING-OF-EXECUTION" [F+]:_

Now, suppose that there is an error in the instruction *follow-until-right-door*, and suppose that you see that this instruction does not run correctly.

- 5 Press  to change the run direction to *backward*.

After you change the Execution direction, this message appears:

Ready to unexecute "follow-until-right-door" in "BEGINNING-OF-EXECUTION" [F.]:_

- 6 Press the  key to undo the entire *follow-until-right-door* defined instruction.

- 7 Next, cancel the instruction trace by typing U. This puts the Simulator back into Monitor mode.

- 8 Finally, single-step into the *follow-until-right-door* defined instruction.

9


Restart the instruction trace inside this instruction by typing **I follow-until-right-door**.

As an alternative, you can change the Execution option to Explain mode.

Explain Execution Mode

The Simulator uses the Explain line (the fourth line on the screen) to provide information on how Karel is running your program. In this mode, the Simulator tells you when Karel starts to do:

- Defined instructions
- BEGIN/END blocks
- Primitive IF, ITERATE, and WHILE instructions
- A test, and what the outcome of each test is

Explain mode begins by displaying an explanation of the first defined instruction or primitive it is going to execute. When you press the  key, the Simulator runs that instruction and immediately displays an explanation of the next instruction it is going to run. Explain mode continues in this way until you have stepped through the entire program.

Note: Explain mode only runs forward; you cannot run a program backward in this mode.

If you ever are unsure about exactly how Karel is running your program, use the Simulator in Explain Execution mode for a slow, very detailed description. The Simulator displays each instruction *before* it is executed, so you can see exactly what is happening.

Explain Mode Commands

The commands available in Explain mode are the same as those in Monitor mode, but there are fewer of them.

Command	Result
---------	--------

C	Configures the Simulator
---	--------------------------

- D** Displays the defined instructions that are currently executing
- L** Looks at a portion of the world
- O** Changes the Execution options
- P** Prints (on your display) the definition of a specified defined instruction

Note: Typing a positive number (**+n**) tells the Simulator to skip forward that many explanations before displaying the default command (**S+1**).

For example, typing **+5** causes the Simulator to skip forward five explanations before you see the default command again.

Typing a negative number (**-n**) tells the Simulator to skip forward that many primitives before displaying the default command (**S+1**).

For example, typing **-5** causes the Simulator to skip forward five primitive instructions before you see the default command again.

Note: There are many more explanations than primitive instructions; therefore, using a negative number skips through the program faster because you are skipping a larger number of individual steps.

Execution Speed

The second Execution option that the Simulator requests is Execution speed:

Enter Execution Speed (Fast, Medium, or Slow)[F]:_

- At *Fast* speed, Karel moves around the display screen, but the Simulator does not update its status line until Karel stops.
- At *Medium* speed, each time Karel starts an instruction, the status line automatically displays what is running.
- At *Slow* speed, the Simulator updates Karel's status and also displays a message telling which instruction Karel just completed.

The default speed is *Fast*. We suggest that you start using the simulator at this speed. If you find that the Simulator is running your program too quickly, use Monitor mode to change the speed. If you decide to use Explain mode, however, you cannot change the speed. You do not see this request because Explain mode runs only at the slowest speed.

Display Mode

The final Execution option is Display mode:

Enter Display Mode (Regular or Sticky)[R]:_

- In *Regular Display* mode, whenever Karel moves off a corner, any beepers on that corner are displayed on the screen.
- In *Sticky Display* mode, whenever Karel moves off a corner, his image remains stuck there. Running the Simulator in Sticky mode is useful for seeing the

path that Karel takes. It can be confusing, however, because you don't see the beepers on any corners where Karel has been.

If Karel repeatedly moves past a corner, only his last image on that corner is displayed. If Karel moves off the current screen and the world is redrawn, the current sticky tracks disappear.

You should start with Regular Display mode. Again, if you use Monitor mode, you easily can change the Display mode between Regular and Sticky.

Post-Execution Options

You see the Post-Execution options whenever the Simulator stops running your robot program.

If Karel executes a *turnoff instruction*, it means your program has run to completion with no errors.

If Karel executes an *error shutoff*, it means that your program has an execution error that prevents Karel from continuing. (Perhaps there is a wall in his way or no beeper where the program told him to pick up one.) In either case, an appropriate message appears on your screen.

If Karel stops because of an error shutoff, you are given a detailed description of the error and where Karel was in the program when the error occurred. In either case, you then are asked to select one of six Post-Execution options:

ReExecute Lets you rerun your Karel program in another initial situation.

When you select the **R** option, the Simulator asks you **Where to get initial situation...** and gives you three choices:

- **Building a new initial situation**

- Using the Current world again (perhaps modifying it for the next use)
- Reading an existing situation from a file

Backtrace

Lets you run your program backward and forward using the current initial situation.

When you use the **B** option, you also are asked to select the three Execution options you want the Simulator to use while running your program backward.

If your Karel program ran too fast the first time, or if it contains an error that you haven't found, run the program backward at fast speed to its beginning; then run it forward at a slower speed (or in Explain mode). You also can use the advanced debugging techniques explained earlier in the Monitor mode section.

Edit

Sends you to the Editor and automatically loads the current program so you can change it.

Save

Lets you temporarily enter the World Builder to save the world currently displayed on the screen.

When you use the **S** option, the Simulator asks you for the name of the file in which you want to store the current world. This file later can be read by the World Builder.

Look

Lets you take a look at any portions of Karel's world that are not currently displayed on the screen. For example,

Karel might do an error shutoff far from the corner that started him on the wrong path.

You can use the **L** option to display that portion of the world.

The Simulator asks you for the coordinates (the street and avenue intersection) that you wish to see. If you type **L 20,10**, the Simulator redraws the world with 20th Street and 10th Avenue centered on the screen. When you are finished looking at that area, another message asks if you'd like to look at a different location.

Quit

Causes the Simulator to stop running the program and return to the Karel System Menu.

Use this option only if you need to modify your program or if you are finished using the Simulator.

Practice Problems



Now, go to the Chapter Five of the textbook and write any of the programs for problems 8 through 14, or go to Chapter Six of the textbook and write any of the programs for problems 1 through 14.

Most of these problems are very hard, so use all of the advanced Simulator procedures that you learned in this chapter to help you find and correct any errors.

Summary

This completes the instructions for operating the Simulator in Experienced mode and your assignments with the textbook. Because there are many choices you must make when using Experienced mode, use the Reference Information whenever you need more details.

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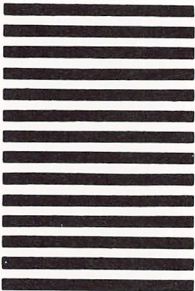
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